### E 3.1.1.3. Technology: A. Innovations

**Activity: Introduction to Robotics**

<table>
<thead>
<tr>
<th>Science as Inquiry: As a result of their activities in grades 5–8, all students should develop</th>
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<tbody>
<tr>
<td>• Understanding about scientific inquiry.</td>
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<tr>
<td>• Abilities necessary to do scientific inquiry: identify questions, design and investigation, collect and interpret data, use evidence, think critically, analyze and predict, communicate, and use mathematics.</td>
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Source: National Science Education Standards

<table>
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<tr>
<th>International Society of Technology in Education (ISTE)</th>
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<tr>
<td><strong>Critical Thinking, Problem Solving, and Decision Making</strong></td>
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<tr>
<td>• Identify and define authentic problems and significant questions for investigation.</td>
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<tr>
<td>• Plan and manage activities to develop a solution or complete a project.</td>
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<tr>
<td>• Collect and analyze data to identify solutions and/or make informed decisions.</td>
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<tr>
<td>• Use multiple processes and diverse perspectives to explore alternative solutions.</td>
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<th>National Science Education Standards (NSES)</th>
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<tr>
<td><strong>Science and Technology in Society</strong></td>
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<tr>
<td>• Technology influences society through its products and processes. Technology influences the quality of life and the ways people act and interact. Technology changes are often accompanied by social, political, and economic changes that can be beneficial or detrimental to individuals and to society. Social needs, attitudes, and values influence the direction of technological development.</td>
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<td>• Technology solutions have intended benefits and unintended consequences. Some consequences can be predicted, others cannot.</td>
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<tr>
<th>National Council of Teachers of Mathematics (NCTM) Expectations</th>
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<tr>
<td>• Understand the need for measuring with standard units and become familiar with standard units in the customary and metric systems.</td>
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Science Process Skills:
- Observing
- Measuring
- Communicating
- Investigating
- Sequencing
- Predicting

Math Process Skills:
- Measuring
- Comparing
- Estimating
- Calculating
- Analyzing
- Problem Solving

Objective:
- The learner will identify and define authentic problems and significant questions for investigation.
- The learner will plan and manage activities to develop a solution or complete a project.
- The learner will collect and analyze data to identify solutions and/or make informed decisions.
- The learner will use multiple processes and diverse perspectives to explore alternative solutions.

Time: 30 minutes

Instructor Materials:
- Computer with robotics software
- Robotics video (see “Resources” section for suggestions) or PowerPoint® slides of robots performing tasks
- Projection system
- Sample robotics program
- Class timer
- 1 instructor robot with wheels (capable of moving in a straight line and turning), appropriate cables, and charger (follow requirements per manufacturer)

Student Materials:
Per team (2 – 6 students)
- 1 robot (same design as instructor robot) with appropriate cables and charger
- 1 computer with robotics software installed
- Laminated program icon cards (optional; see “Note” on page 8)

Note:
- There are numerous robotic systems available for educational use. Be sure to choose a system that allows the robot to move forward as well as turn.

Note:
- To conduct this activity, you will need to create your own sample robotics program. Many manufacturers provide samples. The Internet is also another great resource.
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Instructor Background Information:

**Key Vocabulary**

*Programming Language*—An artificial language used to write instructions that can be translated into machine language and then executed by a computer.

*Robot*—A machine that is programmed to do work on its own, automatically.

*Robotic Program*—Specific operating instructions for a robot.

*Robotics*—The science or study of the technology associated with the design, fabrication, and application of robots.
The Definition of a Robot

A robot is a machine that can do work traditionally done by humans. In fact, the word robot is derived from a Czech word meaning forced labor, robota.

Robots have existed in the human imagination for a very long time and appeared quite regularly in science-fiction stories by the early 1900s. In 1942, Isaac Asimov coined the term “robotics” in one of his short stories. The word referred to “the study of robots” and has become commonplace since then.

Robots are different from other machines because they can be programmed to complete a task without a human operator. Robots have mechanical, electrical, and electronic components that typically include effectors (functioning as arms, legs, hands, or feet), sensors (to detect environmental conditions or surrounding objects), a computer (which controls the robot), and equipment for completing specific tasks. These components give the robot the ability to adapt to variations in the environment and, if necessary, try different methods for completing a task.

In stories, most robots look like humans. In reality, most of them do not. The demands of a specific task often dictate the design of a robot. Those designed to do work traditionally completed by people, however, often need some human attributes, such as manual dexterity and the ability to independently make choices. Some robots have very complex hands and arms they can use to complete intricate tasks. Some also have sophisticated sensory systems that act like a brain. A computer program manages these artificial intelligence systems, analyzing input regarding specific conditions and then proceeds accordingly.

Robotic Applications

Robots are most valuable in situations where humans cannot function efficiently or safely. Robots can repeat a task over and over without making mistakes or getting distracted, tired, or bored. They can work in situations that are uncomfortable or unsafe for humans. They do not need air, food, or water, so they can work in locations where humans cannot.

Inventors around the world have sought to create mechanical helpers throughout history, and in 1961, the first true modern robot went to work for General Motors. In 1954, inventor George Devol introduced the Unimate. To help improve plant efficiency
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and safety, the robot removed and stacked hot metal pieces as they came out of a die-casting machine.

With the modern development of electronic technology, the robotics field has become quite sophisticated. Engineers use computers to design, program, and control robots, and we are even able to use simple designs for everyday tasks in the home. More complex robots perform tasks that are unsafe or impractical for humans, particularly in the fields of manufacturing and space exploration. The National Aeronautics and Space Administration (NASA) uses robots to repair and maintain the International Space Station and satellites. Robots have also assisted in the exploration of Mars.
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Instructor Preparation:

✓ Prepare a large, open area for the students to practice their robotic programming. Review the appendices to determine the necessary requirements.

✓ Create a simulated scenario for the robots to traverse, following the directions as outlined in the applicable appendix.

✓ Assemble robots according to manufacturer’s instructions.

✓ Make sure all robots are charged.

✓ Make sure the robotic computer software is loaded and running properly on the computer for each team.

✓ Optional: Download the selected video (see “Resources” section) to a computer projection system.

Safety

✓ Remind students to be careful with their robots. They are fragile and can break if dropped.

✓ If working on the floor, avoid stepping on robots or teammates’ hands and fingers.
Introduction

1. **Ask:** What do you picture when you hear the word “robot”? (Allow students time to discuss ideas within their team.)

2. Explain that a robot is a machine that we can program to automatically and independently complete tasks. All robots have three things in common:
   
   A. The **control**, or the program, that tells the robot what to do and when to do it;
   
   B. The **body**, which houses the mechanisms that perform actions. (The body can be any shape, from a simple box to a human-like form with arms and legs);
   
   C. The **behavior**, also called the action or output, which the robot will perform according to the directions given.

3. **Ask:** Can you think of any robots you have seen in real life or on television? (Answers might include robotic vacuum cleaners or deep-sea exploration robots.)

4. **Optional:** Show the video that demonstrates robotic applications (see “Resources” section for options). You may choose to use PowerPoint slides with pictures of real-world, television, or movie robots.

5. Have the students complete the “Introduction to Robotics” section on their activity log.

Basic Programming

6. Explain that to have a robot perform actions appropriately, it is critical to program specific commands in a language the robot understands.

   **Optional Demonstration:**

   A. To demonstrate that output behavior is only as good as the provided instructions, use a tooth-brushing or similar scenario:

      Ask for a student volunteer to give instructions, out loud, to the instructor on how to brush their teeth. Using a toothbrush and toothpaste, have the instructor follow the commands **exactly** as given. (This usually begins in a humorous display of the instructor placing the entire tube of toothpaste on top of the toothbrush.)
After explicitly following several instructions, the students will begin to see that to complete a task successfully, commands must be very specific, accurate, and in the correct order.

7. Draw students’ attention to the items they will use for the activity: a computer, a robot, and cables.

8. Demonstrate how to use the programming software, pointing out the functions they will use.
   - As is applicable, discuss the programming icons, menu options, definitions, and associated behavior. Also show the students which settings they may and may not change. (This discussion will vary depending on the programming software available to the students.)

9. Open a sample program that consists of a series of moves, waits (pause), and turn commands. Describe the expected behavior of the robot based on the assigned program function.

10. Show how to edit a command and delete a command. Explain that the programming process is easier if they test each command before adding the next one.

11. If students will need to access their program at another time, walk them through the steps for saving a file. (It may help to save the file using their team name.)

12. Demonstrate how to turn on and connect the robot to the computer (such as USB or Bluetooth).

13. Demonstrate how to download and run the program.

14. In teams, allow students to create a programming sequence, requiring them to use the following
   - Three move commands;
   - One or more turn commands;
   - A wait command, pausing the robot between each move. (Remind them to set the timer for each);
   - Limit tire rotations to five or less. (Encourage the use of decimals, such as 4.5 [if permitted by the software].)
15. As a class, have each team share their program or, depending on available time, select one or two groups to share.

16. Proceed to the robotics appendix of your choosing.

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**Check for Understanding:**

Circulate and monitor students’ programming sequences to ensure understanding. If necessary, have students physically model the commands in their sequence as if they were the robot, which may help them discover problems.
1. A robot is any ____________________________ that can be programmed to do work automatically.

2. The instructions that tell a robot what to do are called the ____________________________

3. All robots have these three things in common:
   A. ____________________________
   B. ____________________________
   C. ____________________________

4. The ____________________________ is the program that tells the robot what to do and when to do it.

5. The ____________________________ can be any shape from a box to something with arms and legs; it houses the mechanisms that perform the action.

6. The ____________________________ or output is the action that the robot will perform on its own, according to the directions given.
1. A robot is any _______________ machine _______________ that can be programmed to do work automatically.

2. The instructions that tell a robot what to do are called the __________________ program __________________

3. All robots have these three things in common:
   A. ___________ control __________________________
   B. ___________ body __________________________
   C. ___________ behavior __________________________

4. The ___________ control __________________________ is the program that tells the robot what to do and when to do it.

5. The ___________ body __________________________ can be any shape from a box to something with arms and legs; it houses the mechanisms that perform the action.

6. The ___________ behavior __________________________ or output is the action that the robot will perform on its own, according to the directions given.
Suggested Final Assessment Questions

1. Which of the following machines is NOT a robot?
   a. Television digital video recorder
   b. Traffic light
   c. Dimension 3-D printer
   d. Radio controlled race car

2. In order, list the steps to program a robot to make a peanut butter sandwich.

3. Which of the following will help ensure a successful program?
   a. The program has specific directions, is accurate, and is in the correct sequence
   b. Each program command is tested before adding an additional command
   c. You use the correct programming language for your particular robot
   d. All of the above
Suggested Final Assessment Questions

**Comprehension**

1. Which of the following machines is NOT a robot?
   
   a. Television digital video recorder
   
   b. Traffic light
   
   c. Dimension 3-D printer
   
   d. Radio controlled race car

**Synthesis**

2. In order, list the steps to program a robot to make a peanut butter sandwich.
   
   (Answers will vary but should be similar.)
   
   Get out two pieces of bread, a jar of peanut butter, a knife and a plate. Place each slice of bread flat on the plate. Open the lid of the peanut butter jar and lay it to the side. Scoop out a portion of peanut butter with the knife and spread the peanut butter on one of the flat sides of one piece of bread. Place one of the flat sides of the other piece of bread on top of the peanut butter, lining up the edges.

**Analysis**

3. Which of the following will help ensure a successful program?
   
   a. The program has specific directions, is accurate, and is in the correct sequence
   
   b. Each program command is tested before adding an additional command
   
   c. You use the correct programming language for your particular robot
   
   d. All of the above
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References:


Related Materials and Educational Resources:

Suggested Videos:


Vendors of Robotic Programming Vehicles:

• http://www.mindstormseducation.com
  » NXT Mindstorms Education Guide (item #9797)
  » NXT Mindstorms Site License
  » NXT Software v1.1 and NXT User Guide CDs
• Fischertechnik at http://www.fischertechnik.biz
  » Robo TX Explorer - item 96 782
  » Robo TX Controller - item #500 995
  » Robo Pro Software - item #93 296